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15c.1 COMPARISON OF THE GFDL HURRICANE MODEL PREDICTION IN THE WESTERN PACIFIC USING THE NOGAPS AND AVN GLOBAL ANALYSIS

by
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1. INTRODUCTION

Beginning in 1995 the GFDL hurricane prediction system was made the official operational hurricane prediction model for the National Weather Service. The forecast system performed well in providing accurate track forecasts during both the 1995 and 1996 hurricane seasons. During 1995 the GFDL model was also tested for typhoons in the western North Pacific, both at the Fleet Numerical Meteorology and Oceanography Center (FNMOC) using the NOGAPS analysis (GFDN) and at the National Centers for Environmental Prediction (NCEP) using the AVN global analysis (GFDS). Based on these test results, the GFDL system was officially made operational by the US Navy for prediction of Western Pacific typhoons, beginning in May of 1996.

Overall, comparison of average track errors during the 1995 season between the two sets of GFDL forecasts using the two analyses, showed considerable skill and comparable performance. However, significant differences in the predicted track were noted in many of the individual cases. Also, detailed analysis of the GFDS results (Wu et al. 1997) revealed systematic biases in the prediction of storm track, with a northward and rightward bias (relative to the storm's heading direction). During the 1996 Western Pacific typhoon season, while the GFDN model continued to provide operational guidance for the US Navy, parallel tests were also carried out for a large number of the cases using the AVN global analysis with the identical vortex specification. Altogether, 177 cases were run in parallel, i.e., 78% of the total number of GFDN forecasts made by the US Navy. Detailed comparisons of these two sets of forecasts will be shown, emphasizing differences and similarities in the distribution of the forecast bias.

2. RESULTS

The average error for both GFDN and GFDS at each forecast period is shown first (Table 1), along with the percent of cases where GFDN exhibited superior performance compared to GFDS. The GFDL forecasts run from the two analyses showed similar performance through 48h, with about a 3% reduction in the average track error with GFDN. At 72h the GFDN forecasts exhibited about an 11% reduction in forecast error over GFDS. This was the only time level where the differences were found to be statistically significant at the 95% confidence level. The spacial distribution of the forecast error (Fig. not shown) showed that both models had largest errors over northern Japan and in the South China Sea, between the Philippines and Vietnam. The forecast error for GFDS was particularly large in these two regions, with average error at 48h of 600 km just east of central Vietnam compared to 450 km for GFDN. Both GFDN and GFDS exhibited smallest errors in the 22^o to 34^o latitudinal band.

Table 1. *Forecast errors (km) for GFDS, GFDN and % of cases with superior performance of GFDN*

Forecast Hour	GFDS	GFDN	% Superior Performance	# Cases
12	109	108	51%	177
24	180	170	51%	166
36	229	220	48%	153
48	281	277	46%	143
72	470	416	58%	114

Interestingly, when composite forecasts (GFDA) were made by averaging the forecast positions of the GFDN and GFDS models together, the mean error at each time level was significantly reduced and was less than the error for either individual model (Table 2) at every time period. The improvement over the GFDS track error was found to be statistically significant at every time level and at all time levels except 72h compared to GFDN.

Table 2. *Forecast errors (km) for GFDA and % superior performance of GFDA compared to GFDS and GFDN*

Forecast Hour	GFDA	% Superior Performance Against GFDS	% Superior Performance Against GFDN
12	102	61%	55%
24	160	64%	58%
36	205	61%	63%
48	254	55%	62%
72	403	63%	51%

Fig. 1 shows the distribution of the mean position error bias (the head, tail, and length of each arrow represents the GFDL forecast position, verifying position, and the actual position bias in degrees, respectively) at

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48h for both GFDN and GFDS. Similar to the 1995 season, the result indicates a general northward bias for GFDS in the region south of 30°N. North of 30° the strong westward basis during the 1995 season, was somewhat reduced in 1996 with more of a northward bias east of 140°. For GFDN, except for a slight northward bias just east of Taiwan, a southward bias occurred in much of the rest of the region south of 30° and west of 140°. North of 30° GFDN had strong westward bias through much of the region. Overall, the spacial bias of the models differed in many places, although similarities were found in the location of the regions of largest and smallest errors.

When the track was decomposed into its cross-track and along-track component, it was found that both GFDN and GFDS showed some slow bias (Fig. 2). The average bias was considerably larger for GFDN beyond 24h with mean values in the along-track component of -5, -48, -64 km compared to -16, -23, and -37 km for GFDS at 24, 48 and 72h, respectively. In the cross-track direction, GFDN exhibited a left bias with mean values of -10, -40 and -54 km at 24, 48 and 72h. The large right bias in GFDS observed during the 1995 season (e.g., 56, 110 and 164 km) was not found in 1996 as the mean cross track error even became slightly negative at the later time periods (i.e., 8, -9 and -25 km at 24, 48 and 72h).

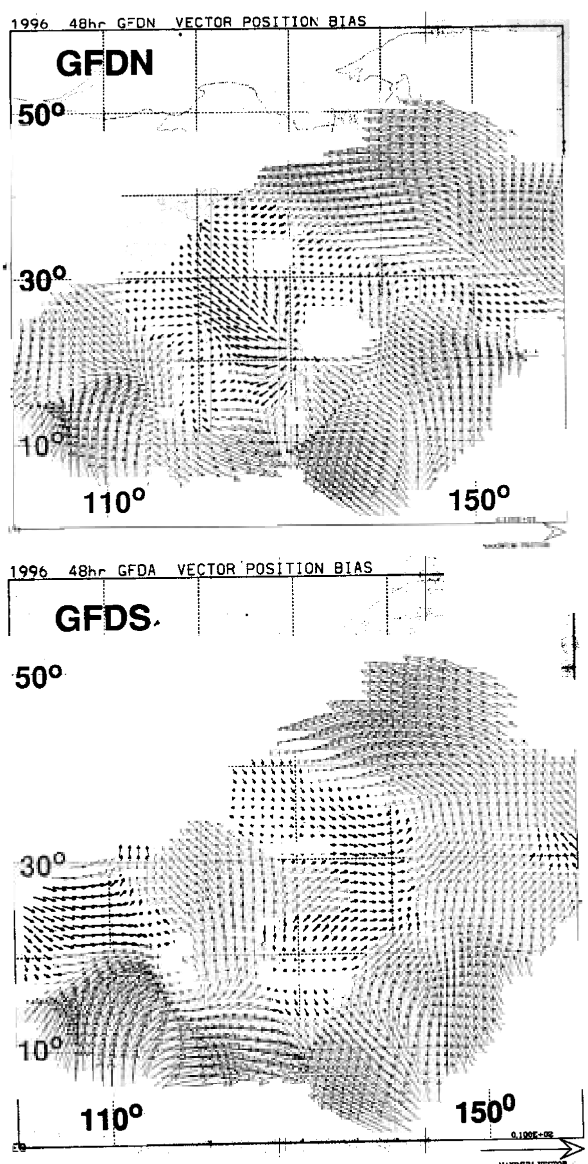

Fig. 1 *Systematic bias of GFDN and GFDS at 48h*

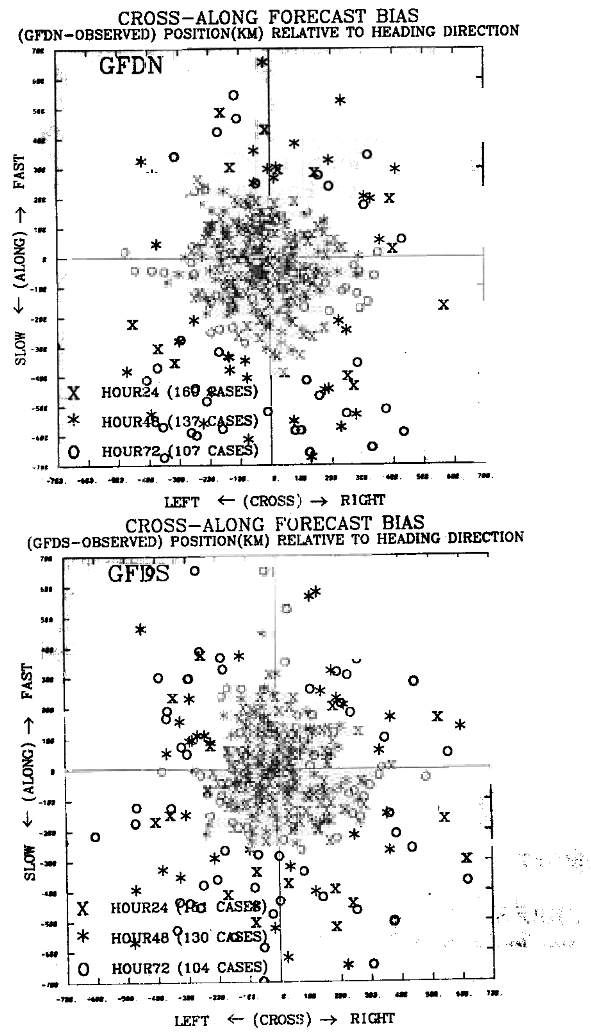

Fig. 2 *Scatter diagram of GFDN and GFDS cross-track (abscissa) and along-track (ordinate) forecast errors. The ordinate points toward the storm's heading direction.*

REFERENCES

Chun-Chieh Wu, M.A. Bender and Yoshio Kurihara, 1997: Evaluation of the GFDL Hurricane Prediction System in the western North Pacific in 1995. Submitted to *Weather and Forecasting*.